SPECIFICATION

1. TITLE OF THE INVENTION

Resist Removing Method

2. CLAIMS

(1) Resist removing method comprising the steps for:

selectively etching the layer to be etched by a reaction gas including chlorine-compound gas with the resist layer used as an etching mask;

thereafter ashing said resist layer with an ashing gas and

simultaneously removing said chlorine-compound gas as the hydrochloric acid with the water mixing the ashing gas.

(2) Resist removing method according to claim (1), wherein said layer to be etched is aluminium layer or aluminium alloy layer.

3. DETAILED DESCRIPTION OF THE INVENTION

[Summary of the Invention]

In relation to an improvement of a resist removing method in the lithography technology, it is an object of the present invention to control after-corrosion, which may be attained by the resist removing method comprising the steps for selectively etching the layer to be etched by a reaction gas including chlorine-compound gas with the resist layer used as an etching

mask; thereafter ashing the resist layer with an ashing gas and simultaneously removing the chlorine-compound gas as the hydrochloric acid with the water mixing the ashing gas. In such resist removing method, the layer to be etched is aluminium layer or aluminium alloy layer.

[Industrial Applicability]

The present invention relates to an improvement of a resist removing method in the lithography technology.

The lithography technology is extremely important in a semiconductor device manufacturing method. The present invention relates to a resist removing method for ensuring high reliability in the lithography technology.

[Description of the Prior Art]

A surface of wafer (semiconductor substrate; substrate to be etched) is coated with resist and a resist layer pattern is formed by projecting and developing a predetermined pattern thereto. Thereafter, the wafer is etched with the resist layer pattern used as a mask. Finally, pattern formation is completed by removing resist layer pattern.

The processes explained above are summary of the lithography technology. As an example, the process sequence of patterning of aluminium wiring is shown in Figs. 3(a) ~ (c).

Referring to Fig. 3(a):

An aluminium layer 2 (thickness is about 1 μm) is coated on

a semiconductor substrate 1, resist is then coated thereon and a predetermined pattern of resist layer 3 (layer thickness is 1～2 μm) by projecting and developing the predetermined pattern.

Referring to Fig. 3(b):

Thereafter, the aluminium layer 2 is etched utilizing the chlorine ($C\ell_2$) gas with the resist layer 3 used as the mask. As the etching method for the wiring, a reactive ion etching (RIE) method is generally used.

Referring to Fig. 3(c):

Thereafter, the resist layer 3 used as the resist mask is removed by the ashing method.

Fig. 4 shows an automatic processing system diagram to form the patterns explained above. In this example, a load lock chambers 13 are provided between the RIE apparatus 11 (an apparatus for realizing the RIE method) and the ashing apparatus 12 (an apparatus for realizing the ashing method) and in both sides thereof. In this processing system, a wafer 1 coated with resist layer is automatically etched and the resist layer is successively removed automatically. For the automatic etching system, a dry-etching method such as RIE method is suitable and moreover the dry-process method (ashing method) to remove the resist by heating the resist in the oxygen plasma gas and then ashing it is suitable for removing the resist. In addition to the dry-process method, the wet-process method to dissolve and

remove the resist by soaking the resist into an organic solvented has been proposed to remove the resist, but since the wet-process method is required to execute complicated processings for chemical solutions, only the ashing apparatus in the dry-process method which executes simple processings for chemical solutions is now increasingly used.

[Problems to be Solved by the Invention]

For the wirings (within the chip) of semiconductor devices such as IC, LSI, aluminium or aluminium alloy is generally used, and the chlorine-compound gas such as chlorine ($C\ell_2$), boron chloride ($BC\ell_3$) and silicon tetrachloride($S_iC\ell_4$) is used as the reaction gas for patterning of aluminium wiring and its alloy wiring.

However, if a chlorine-compound gas is used, chlorine may easily be left after the etching and it reacts thereafter with water content in the air to form hydrochloric acid ($HC\ell$), which may particularly corrodes aluminium. It is called after corrosion. This after corrosion has a defect to corrode the wirings and lower reliability thereof. Figs. 5(a), (b) are diagrams for explaining the problems of prior art which result in after corrosion. Fig. 5(a) shows the condition that chlorine ($C\ell$) is adhered to the aluminium wiring 2 on a semiconductor substrate 1 after the process shown in Fig. 3. Next, when the semiconductor substrate is exposed to the open air, chlorine (C

ℓ) reacts with water content (H_2O) to form hydrochloric acid (HCℓ) which corrodes the aluminium wirings 2.

In such automatic processing system, after the etching in the RIE apparatus 11, a semiconductor is transferred under the vacuum condition through the load lock chamber without being exposed to the open air and peeling of resist is carried out in the ashing apparatus 12. Thereby, the resist layer may be removed under the vacuum condition. Such resist layer includes a large amount of chlorine after the etching process. But when it is removed under the vacuum condition, after corrosion is considerably suppressed.

However, in these years, an aluminium-copper (Aℓ -Cu) alloy which is resistive to electro-migration and stress-migration has been used in place of pure aluminium for the internal wirings and moreover a barrier metal such as titanium nitride (TiN) or tungsten nitride (TiW) has also often been used. Such aluminium-copper alloy and barrier metal so far easily generate the after corrosion than pure aluminium and aluminium-silicon (Aℓ - Si) alloy due to the principle that a battery is formed between different kinds of metals. Accordingly, it recently becomes difficult to perfectly control the after corrosion even through the processing by the automatic processing system explained above.

The present invention proposes a resist removing method which eliminates the problems explained above and suppresses the

after corrosion.

[Means for Solving the Problems]

Such problems are solved by the resist removing method based on the principle shown in Fig, 1, wherein after a layer to be etched 2 (for example, aluminium layer or aluminium alloy layer) on a semiconductor substrate 1 is selectively etched by a reaction gas including chlorine-compound gas with the resist layer 3 used as the mask, the resist layer is ashed and removed with the ashing gas ($O^{\bullet}$) and simultaneously the chlorine-compound gas is removed as the hydrochloric acid with water content (H_2O) mixed in the ashing gas.

[Operation]

Namely, the present invention proposes a method in which water (H_2O) is mixed into the ashing gas, the water content reacts with the remaining chlorine ($C\ell$) to be evaporated and evacuated as the hydrochloric acid ($HC\ell$), and chlorine ($C\ell$) is removed perfectly from a semiconductor substrate (wafer) by the ashing process for removing the resist.

Thereby, a high quality layer to be etched which does not allow generation of after corrosion can be formed.

[Embodiment of the Invention]

The present invention will be explained in detail with reference to the embodiment thereof. Fig. 2 is a sectional view of the essential portion of an ashing apparatus to which the

present invention is applied. This ashing apparatus is of a down-flow type which gives less damage to the wafer. In Fig. 2, the reference numeral 1 denotes a wafer; 21, a plasma generation chamber; 22, an ashing chamber which causes oxygen (O_2) gas to enter the plasma generation chamber 21 from a gas inlet port, generates plasma by supplying the microwave from a microwave power supply 23 to such oxygen gas and then guides such plasma to the ashing chamber 22. When the ashing chamber 22 is exhausted through an exhaust port 26, the plasma is guided into the ashing chamber, and the resist layer on the one surface of wafer 1 put on the heating stage 24 of the ashing chamber is ashed. In the processing method of the present invention, on the occasion of guiding the oxygen (O_2) gas from the gas inlet port 25, water (H_2O) is mixed with the oxygen gas by about 10% and, as shown in the principle diagram, the resist layer 3 is ashed and removed by the plasma oxygen gas ($O^{\cdot}$) and the mixed water is reacted with chlorine ($C\ell$). Thereby the hydrochloric acid ($HC\ell$) gas is generated through vaporization and this hydrochloric acid gas is exhausted. When is water is mixed, molecules of water and atoms of hydrogen react with chlorine to generate the hydrochloric acid. This hydrochloric acid gas of low pressure is vaporized in the vacuum condition and is easily exhausted. Thereby, chlorine can easily be removed from the wafer (semiconductor substrate).

As the ashing gas (plasma gas for ashing), only the oxygen

(O_2) gas may be used, but the oxygen gas adding the nitrogen (N_2) gas or fleon (CF_4) gas of about 10% to pure oxygen gas may also be used for easy removal of resist layer. In this case, it is recommended to further add water to the oxygen gas.

Next, result of employment of the method disclosed by the present invention will be explained. An aluminium-copper alloy (Aℓ -2%Cu) is coated on the wafer and a wiring pattern is formed by the RIE apparatus 11 using an automatic processing system shown in Fig. 4 with the resist layer used as the mask. In this case, etching is carried out using a mixed gas of chlorine ($Cℓ_2$) and silicon tetrachloride ($SiCℓ_4$) as the reaction gas.

Thereafter, the wafer having completed the etching is then guided to the ashing apparatus through the load lock chamber under the vacuum condition. The resist layer is then ashed in the ashing apparatus 12. As the ashing gas, oxygen (O_2) of 1~2 sℓm (standard ℓ/min.), water (H_2O) of 100~300 sccm (standard cc/min.) are applied. This mixed gas is kept at the reduced pressure of about 1 Torr. Moreover, the temperature of the heating stage 24 on which the wafer put is raised up to about 100 ~ 200℃. Thereafter, the resist has been removed by applying the power (microwave frequency of 2.45 MHz) of 1.5 kW.

As a result, after corrosion has not been generated even after the wafer has been left under the open air for 48 hours. Meanwhile, in the case of resist removing by the prior art method

where water is not mixed, after corrosion has been generated after the wafer is left only for an hour under the open air. From this result, it is obvious that distinctive improvement has been realized by the present invention.

[Effect of the Invention]

As will be understood from above explanation, according to the resist removing method of the present invention, generation of after corrosion is remarkably suppressed, resulting in large effection realization of high reliability of semiconductor devices.

4. BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a diagram indicating the principle of the present invention;

Fig. 2 is a sectional view of the essential portion of an ashing apparatus to which the present invention is applied;

Figs. 3(a)~(c) are processing sequence diagrams for patterning of aluminium wirings;

Fig. 4 is a diagram indicating an automatic processing system; and

Fig. 5 is a diagram for explaining problems of the prior art; in whch:

1.....semiconductor substrate or wafer;

2.....layer to be etched, aluminium layer or aluminium

wiring;

3.....resist layer;

11....RIE apparatus;

12....ashing apparatus;

13....load lock chamber;

21....plasma generation chamber;

22....ashing chamber.

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